European Management Review, (2018)
DOI: 10.1111/emre.12324

25 Years of Real Option Empirical Research in Management

EDITH IPSMILLER,[1] KEITH D. BROUTHERS[2] and DESISLAVA DIKOVA[1]
[1]WU Vienna, Austria
[2]King's College London, UK

For several decades, management scholars have extolled the virtues of using real option logic when making decisions under uncertainty. Real option logic suggests that in such situations, firms might be better off deferring or staging investments, reducing potential financial losses, while at the same time securing an option to grow (or abandon) the investment when uncertainty abates. Our analysis of the empirical research published in leading management journals over the past 25 years suggests that while some progress has been made, much more work needs to be done. We still do not have the answers to critical questions such as: Which entrepreneurial/managerial traits impact the identification or exploitation of real options? Do multiple types of uncertainties interact with each other and influence real option decisions? Addressing these and other issues identified in our study can help improve our understanding of the usefulness of real option logic in management.

Keywords: literature review; strategic management; international management; real options theory

Introduction

Over the past 25 years, management scholars have applied real option logic to a growing number of decisions including investments in new technology (McGrath and Nerkar, 2004), new international markets (Brouthers *et al.,* 2008) and entrepreneurial ventures (Folta *et al.,* 2010). The term 'real option' was coined by Stewart Myers (1977: 150), who argued that firms can be seen as a combination of two types of assets, real assets and real options, which Myers (1977: 150) defined as 'opportunities to purchase real assets on possibly favorable terms'. As opposed to financial options, which constitute investments in financial instruments, real options refer to investments in real property. Financial options (the right to buy/sell some financial security in the future) are obtained by making a small investment when uncertainty is high. This small investment reduces current resource commitments but gives the investor an option to buy/sell the security at a specific price, at some point in the future. Real option logic works in a similar way (for a comparison see Mun, 2002 or Janney and Dess, 2004). Basically, real option logic suggests that when making decisions in uncertain situations, firms can defer investment or make a small investment. This way, they can obtain an option to benefit from potential future opportunities while reducing current financial obligations, thus lowering downside risk (McGrath, 1997; Janney and Dess, 2004).

Since the theory's introduction, different real option methodologies have evolved. Whereas economists use real option logic to calculate a real option value (referred to as 'real options valuation'), management scholars typically apply 'real options reasoning', which uses real option logic without calculating an option's value (Driouchi and Bennett, 2012). Consequently, instead of determining the value of a real option (often using Black and Scholes models; see Dixit and Pindyck, 1994), management researchers focus on its value drivers (uncertainty and other variables).

Real option logic was developed to help managers make better decisions when faced with uncertainty (Dixit and Pindyck, 1994). To deal with uncertainty and provide some protection from downside risk, real option logic considers the flexibility managers have to adjust investments in the future (Copeland and Keenan, 1998; Krychowski and Quelin, 2010). Discounted cash flow models do not recognize this flexibility and instead assume firms make the full investment or make no investment (Newton *et al.,* 2004). Real option logic suggests that under uncertainty, firms might want to take

Correspondence: Edith Ipsmiller, Institute for International Business, WU Vienna, Welthandelsplatz 1, 1020 Vienna, Austria. E-mail: edith.ipsmiller@wu.ac.at

a 'wait and see' or an 'invest and see' approach (Dixit and Pindyck, 1994). In the 'wait and see' situation, managers initially defer investment and later make an investment, abandon the investment, or continue to wait. Taking an 'invest and see' approach means that firms will make a small initial investment and later make additional investments, abandon the investment, or continue to wait. This second approach is used when a small investment can provide access to proprietary information, affording the investing firm an opportunity to generate first mover advantages, close distribution channels to followers, restrict rivals' access to limited resources, or tie up potential partner organizations (Bowman and Hurry, 1993; Rivoli and Salorio, 1996). In either case, the managerial flexibility provided by real option decision models enables firms to reduce downside risk while maintaining upside potential.

In this paper, we make a number of contributions to knowledge by reviewing the empirical real option research in top management journals over the past 25 years. First, we contribute to this work by undertaking a systematic method to review the literature. There already exist several real option reviews/critiques in management (e.g., Adner and Levinthal, 2004; Newton *et al.,* 2004; Ragozzino *et al.,* 2016). Each of these papers provides interesting insights about the real option literature. However, none of the past reviews/critiques utilizes a systematic method of identifying literature. Using a systematic method to review prior research is important because it provides an evidence-based, replicable method of identifying and synthesizing literature (Briner and Denyer, 2012). This method attempts to reduce bias and make any biases explicit (Gough, 2007). While other review methods, such as thematic or expert reviews, provide valuable insights, systematic methods provide 'a basis for assessing the quality and relevance of research findings' (Gough, 2007: 216). Consequently, systematic reviews provide the opportunity to consolidate learning for a particular research area. Such learning is important because research on real options theory is very diverse, especially regarding fundamental questions such as what constitutes a real option (investment) (Adner and Levinthal, 2004; Cuypers and Martin, 2010), which variables explain real option investment decisions and how they are measured. Moreover, it has been argued that '[f]or practitioners/managers, systematic review helps develop a reliable knowledge base by accumulating knowledge from a range of studies' (Tranfield *et al.,* 2003: 220). Considering low application rates of real options theory in practice (Ghahremani *et al.,* 2012), this systematic review can help managers to better understand the theory and might contribute to higher usage in the future.

Second, we make no *a priori* decisions on the topics to be included in our review. Instead, we look at all the empirical real option articles our systematic method generated and from that determine the topics covered. This allows us to capture all areas of research that have been addressed by the empirical real option research in management over the past 25 years and facilitates our identification of topics that still have not been the subject of empirical investigation.

Finally, based on the evidence found, we develop a model of real option decision-making that guides our discussion of the respective literature. While most of the previous reviews provide models of real option logic (e.g., Burger-Helmchen, 2007; Reuer and Tong, 2007; Smit and Trigeorgis, 2017), there is no agreement about the issues included. These models share some issues in common, but differ in how they categorize them. Thanks to our systematic approach, our model provides a comprehensive portrayal of the empirical real option research in management. It represents the centerpiece of our systematic review as each of its components is discussed consecutively and in detail. Furthermore, it also provides a basis for the identification of research gaps and for our suggestions for future research. Overall, our model outlines the basic real option logic for investments under uncertainty.

Methodology

We use a systematic literature review methodology to take stock and assess empirical work on real options theory (ROT) and to highlight opportunities for future advancement of the field. Having its roots in medical sciences, the systematic literature review methodology has also increasingly attracted attention by management scholars (for examples see Pittaway *et al.,* 2004; Crossan and Apaydin, 2010; or Schmeisser, 2013). Systematic literature reviews differ from traditional, narrative reviews in several important aspects (Denyer and Tranfield, 2009). According to Tranfield *et al.* (2003), a systematic review methodology involves a three-stage process. It starts with a planning stage, in which the relevance and the content of the review are determined, followed by conducting the review (stage 2) and reporting/disseminating the results (stage 3). After having identified the relevance and content of our systematic review as described in the introduction, we went about identifying empirical real option publications in management. We restricted our review to articles published in the top eight empirical management journals (*Academy of Management Journal*, *Strategic Management Journal*, *Administrative Science Quarterly*, *Journal of International Business Studies*, *Journal of Management*, *Journal of Management Studies*, *Management Science*, and *Organization Science*). This journal selection is based on other systematic literature reviews – Armstrong and Shimizu's (2007) review of

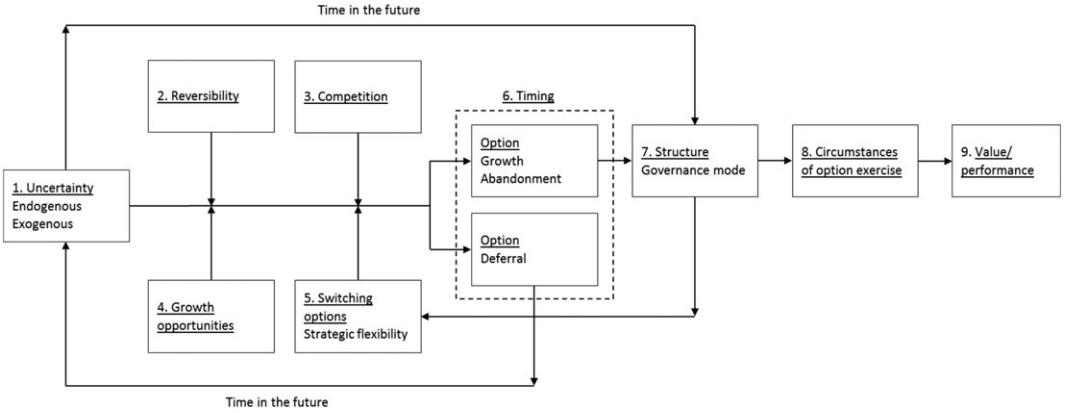

Figure 1 Model of real option research in management

empirical research on the resource-based view of the firm and Barreto's (2010) review on dynamic capabilities. We used the databases Business Source Premier and Proquest to identify all articles published in these journals between 1991 and 2015 that mention 'real option' in the title, abstract or keywords. These articles were read in detail with the objective of eliminating all papers that only tangentially treated real options. Studies were also located by examining the reference list of the articles identified through this keyword search. These articles provide the basis for our systematic discussion of the empirical real options literature. However, we also refer to additional literature on ROT in other journals (e.g., Janney and Dess, 2004; Moschieri and Mair, 2017) and in books (e.g., Dixit and Pindyck, 1994; Mun, 2002) to explain theoretical concepts or to highlight important studies that could help advance the theory and its application. All articles without data were classified as theoretical articles (which include many of the real option valuation papers in management that rely on modelling the real option decision). After all these steps, a total of 54 empirical articles were identified, which we summarize in an Appendix.[1]

Based on these articles and books as well as our reading of past real option reviews, we developed a model of the real option decision-making process (Figure 1). This model identifies the antecedents, moderators, options, structure and outcomes of the real option process, which will guide our discussion of the empirical literature. As in Li (2007), our reading of the literature indicates that uncertainty is the primary antecedent of real option decisions. Based on the level of uncertainty, managers determine whether to make or defer an investment. We identified four factors that moderate this decision. These factors – (ir)reversibility, competition, growth opportunities and switching options – can increase/decrease the potential exposure to downside risk and to upside potential in decisions involving uncertainties. In addition, our review identified investment timing and the options firms may take in investments involving uncertainty: defer investment or acquire a growth/abandonment option. For those obtaining a growth/abandonment option, the structure of the option (investment structure) needs to be determined. Then, in the future, as the uncertainties surrounding the decision become clearer, firms may decide to exercise the option. Finally, some real option research explores the value of holding options and the performance consequences of taking a real option approach. Below, we discuss each of the components of the model, the related research and the shortcomings and opportunities for future research.

A model of real option decision-making

Our model of real option decision-making summarizes the empirical real option literature we systematically identified as described above. While antecedents and moderators (components 1–5) mainly represent explanatory variables, components 6–9 refer to the outcome variables investigated in the respective papers. Information in the second column of the Appendix indicates which components of the model are discussed in each of the papers. In the following sections, we examine each of the components of the model in detail.

Antecedents

Real option research indicates that *uncertainty* is the most critical antecedent to real option decisions (McGrath, 1997; Reuer and Tong, 2007). Uncertainty can be endogenous or exogenous (Dixit and Pindyck, 1994; Chi and McGuire, 1996). Endogenous uncertainties stem from a lack of knowledge (McGrath, 1999) and can be dealt with through firm investment (Dixit and Pindyck, 1994). Exogenous uncertainties reside in the external environment and are largely unaffected by firm actions, but become clearer over time (Folta, 1998; Chi, 2000).

[1]Available via: https://www.researchgate.net/publication/325822608_Appendix_-_Empirical_Research_Using_Real_Option_Logic

Most of the empirical real option research we found applies real option logic to decisions involving exogenous uncertainties and, to a lesser extent, endogenous uncertainties. One reason for this might be that other theories, such as transaction cost (Williamson, 1985), provide guidance to managers when dealing with endogenous uncertainties. Because firms are often confronted with both exogenous and endogenous uncertainties when making investment decisions and these two types of uncertainty provoke contrary pressures on firms (Cuypers and Martin, 2010), a number of papers in our review combine real option logic with other theories (e.g., Leiblein and Miller, 2003; Brouthers *et al.,* 2008).

As noted in Table 1, uncertainty can focus on a number of issues depending on the investment decision under consideration. For example, in technology or R&D-based decisions, exogenous technical uncertainties are of primary concern (e.g., Steensma and Corley, 2001; McGrath and Nerkar, 2004), while for decisions focusing on market expansion, exogenous demand uncertainty is of critical importance (e.g., Brouthers *et al.,* 2008; Li and Li, 2010).

There are, however, a number of issues with the uncertainties included in current research that provide opportunities for future studies. First, Table 1 indicates that researchers often use industry-level proxies of demand uncertainties (e.g., Folta and O'Brien, 2004) and firm-level experience or knowledge proxies for technical uncertainties (e.g., Kim and Kogut, 1996; Ziedonis, 2007). Since exogenous uncertainties are not firm or industry dependent (Li, 2007; Cuypers and Martin, 2010), the use of these proxies raises questions about their appropriateness. Exogenous uncertainties have more to do with whether a specific technology will work or whether consumers will buy a firm's products (McGrath, 1997; Steensma and Corley, 2001). Thus, future research

Table 1 Types of uncertainty

Type	*Example measures*	*Sample studies*
Demand uncertainty	Industry uncertainty	Folta and O'Brien (2004)
		Damaraju *et al.* (2015)
	Stock exchange volatility	Tong and Li (2011)
	Industry production volatility	Campa (1994)
	Industry demand volatility	Li and Li (2010)
		Elfenbein and Knott (2015)
	Perceived demand uncertainty	Brouthers *et al.* (2008)
	Target industry experience	Folta *et al.* (2010)
Technology uncertainty	Industry R&D intensity	Chari and Chang (2009)
	Perceived technology uncertainty	Steensma and Corley (2001)
		Jiang *et al.* (2009)
	Technical experience	Kim and Kogut (1996)
		McGrath and Nerkar (2004)
	Technical knowledge	Warner *et al.* (2006)
		Ziedonis (2007)
		Cuervo–Cazurra and Un (2010)
	Technical distance	Folta (1998)
		Colombo (2003)
		Reuer and Tong (2005)
		Xu *et al.* (2010)
	Self–employment experience	Folta *et al.* (2010)
	Entrepreneurial experience	Raffiee and Feng (2014)
Macroeconomic uncertainty	Price volatility	Campa (1994)
	Country risk	Chari and Chang (2009)
		Cuypers and Martin (2010)
	Exchange rate	Campa (1994)
		Belderbos and Zou (2009)
		Cuypers and Martin (2010)
	Institutional/Cultural	Cuypers and Martin (2010)
		Reuer and Tong (2005)
		Tong and Reuer (2007)
		Chari and Chang (2009)
	Political risk	Reuer and Tong (2005)
Partner uncertainty	Perceived threat of opportunism	Steensma and Corley (2001)
	Prior experience with partner	Santoro and McGill (2005)
		Villalonga and McGahan (2005)
		Warner *et al.* (2006)
		Tong and Li (2013)
	Public/Private firm	Xu *et al.* (2010)

needs to be sure that the uncertainty measures used are capturing exogenous uncertainties and not endogenous uncertainties, which firms can reduce through investment.

Second, when making investment decisions, firms tend to face multiple uncertainties, not just one (McGrath, 1997; Huchzermeier and Loch, 2001). In the 54 papers we reviewed, only eight studies included multiple types of uncertainties in their models. This is problematic since both investments in technology and market entry investments (the main focus of real option empirical management research) involve multiple sources of uncertainty. Therefore, much of the past research might have underestimated the impact of uncertainties. Hence, future research can develop and test new models that identify and explain how different types of uncertainties (e.g., demand, technical, macroeconomic, etc.) are related to a particular investment decision and develop a better understanding of how real option choices can help managers deal with these various sources of uncertainty.

Moderators (conditioning factors)

ROT suggests a number of factors that can moderate decisions involving uncertainties. The first moderator we identified is the (ir)*reversibility* of the investment (Driouchi and Bennett, 2012). If an investment is completely reversible and exogenous uncertainties do not resolve as hoped, a firm can simply reverse the investment and recover its funds (Li and Li, 2010). Yet, when the investment is irreversible, firms need to think carefully before committing resources as they may face substantial losses if the investment does not work out (Sanchez, 1993; Li and Li, 2010).

Our review reveals that although most studies include a discussion of irreversibility in the theory section, only six of the 54 empirical studies examined have developed and tested proxies for this factor (Table 2, Panel A). Of these, investment size-related measures are problematic because simply having a large or small investment does not in itself expose the firm to greater/lesser downside risk if the investment is reversible. Studies looking at investment size may actually be measuring other effects, such as managerial risk propensity and reluctance to make larger investments, or the negative framing of large investment decisions (Sitkin and Weingart, 1995; Drummond, 2014). The alternative proxy, perceived irreversibility (Jiang *et al.,* 2009), more directly addresses this important real option moderator, but only one study has used this type of measure. Consequently, more research is needed that directly measures the degree of reversibility, for example by using perceptual measures of investment irreversibility as developed by Jiang *et al*. (2009).

The second moderator we found in our review is *competition*. When confronted with uncertainty in an investment decision, firms might like to defer investment until the future becomes clearer, thus reducing downside risk to zero. Yet, waiting to act has potential costs since competitors can take actions that reduce the investment options available to the focal firm in the future (McGrath, 1997; Folta and Miller, 2002). Real option logic suggests that firms facing competition should make small investments to gain a foothold and not fall behind competitors who might also invest (McGrath, 1997). These small investments can provide a signal to competitors or allow the focal firm to get proprietary access to resources or market/technical knowledge (Sanchez, 1993; Trigeorgis, 1996).

Yet, understanding competitors and their strategies is a difficult task since this information is normally not publicly available and competitive signals in the environment might be distorted (Clark and Montgomery, 1996). Despite these barriers, consideration of potential competitive moves is an important part of making investment decisions according to real option logic. Most studies looking at this issue (Table 2, Panel B) simply examine the number of competitors a firm has or the industry concentration of competitors without considering the potential threat these competitors pose. However, just because a firm has more (less) competitors does not mean that these competitors will (not) act. Real option decisions are impacted by competitors if these competitors are likely to make (or have made) similar or related investments (McGrath and Nerkar, 2004). Only two studies in our review examined competitor actions and the potential threat they create. Future research can make an important contribution in this area by developing more robust measures of competitor actions. This can be achieved, for example, by developing perceptual indicators – measuring how a firm making an investment decision assesses its competitors on their willingness and ability to make similar investments.

Real option research speaks much less frequently about the third moderator, *growth opportunities*. When dealing with exogenous uncertainties, real option logic suggests that firms try to reduce the level of resources put at risk while capturing the potential to exploit opportunities if and when they develop. Growth opportunities are a measure of the variance in potential performance outcomes in such decisions (McGrath and Nerkar, 2004). When there is little uncertainty, the variance in potential opportunities is relatively low and managers can estimate best/worst case scenarios and calculate the investment's net present value. Yet, in the presence of exogenous uncertainties, the variance in potential outcomes increases, making a real option approach worthwhile.

The research we reviewed measured growth opportunities as either growth potential or competitive advantage (Table 2, Panel C). The problem with these measures (with the exception of Steensma and Corley, 2001) is that they all rely on markets,

Table 2 Real option moderators

Panel A: types of irreversibility		
Type	*Example measures*	*Sample studies*
Size of investment	Target operation size	Chari and Chang (2009) Brouthers and Dikova (2010)
	Industry average investment	Folta and O'Brien (2004) Li and Li (2010) Tong and Li (2011)
Perceived irreversibility		Jiang *et al.* (2009)
Panel B: types of competition		
Type	*Example measures*	*Sample studies*
Size	Number of competitors	Kogut (1991) Kim and Kogut (1996) Folta (1998) Folta and Miller (2002) McGrath and Nerkar (2004) Brouthers and Dikova (2010)
Commitment	Competitor commitment	McGrath and Nerkar (2004) Li and Li (2010) Tong and Li (2011)
First mover	Perceived threat of pre–emption	Jiang *et al.* (2009)
Panel C: types of growth opportunities		
Type	*Example measures*	*Sample studies*
Growth potential	Growth in industry shipments	Kim and Kogut (1996)
	Industry sales growth	Kogut (1991) Li and Li (2010)
	Predicted industry GDP growth	Folta and O'Brien (2004)
	Median industry market/book ratio	Folta and O'Brien (2004) Tong and Li (2011)
	Scope of opportunity	McGrath and Nerkar (2004)
	Growth option value	Reuer and Tong (2010)
Competitive advantage	Perceived opportunity for advantage	Steensma and Corley (2001)
	Scale advantage	Folta and O'Brien (2004)
	Proprietary option	Folta and Miller (2002)
Panel D: types of switching options/strategic flexibility		
Type	*Example measures*	*Sample studies*
Foreign experience	Foreign acquisition experience	Brouthers and Dikova (2010)
	Years international/regional experience	Brouthers *et al.* (2008)
	Multinationality	Reuer and Leiblein (2000) Belderbos and Zou (2007) Tong and Reuer (2007) Lee and Makhija (2009a) Belderbos and Zou (2009) Chung *et al.* (2010) Fisch and Zschoche (2012) Belderbos *et al.* (2014)
	Number of countries	Brouthers *et al.* (2008) Chung *et al.* (2010) Belderbos *et al.* (2014)
	Number of foreign subsidiaries	Fisch (2008)
Product experience	Product diversity	Leiblein and Miller (2003)
Labor diversity	Variance in wage growth	Fisch and Zschoche (2012)
	Correlation of labor costs	Belderbos *et al.* (2014)
Exchange rate	Correlation of exchange rates	Belderbos and Zou (2009) Chung *et al.* (2010)
Portfolio	Portfolio focus	Li and Chi (2013)
	Portfolio diversity	Li and Chi (2013)
Ownership	Equity ownership share	Belderbos *et al.* (2014)
	Expatriate ratio	Belderbos *et al.* (2014)

technologies, and consumers being consistent over time (an extrapolation of the past). But one critical factor that makes investments in the future uncertain is the potential to generate new streams of revenue by creating new products or technologies that significantly shift consumer demand from existing markets and technologies. Hence, making real option decisions based on extrapolation of past trends runs counter to the ideas behind real option logic (McGrath, 1999). Future research could make an important contribution by developing measures and methods managers can use to more accurately estimate the level of growth opportunities, for example by integrating insights from scenario planning (Schoemaker, 1995) or by developing perceptual measures (as in Steensma and Corley, 2001).

Switching options, also called strategic flexibility, is the fourth moderator we identified. Switching options are a reflection of a firm's ability to make alternative use of an investment (Sanchez, 1993; Driouchi and Bennett, 2012). They provide firms with strategic flexibility, i.e. 'the ability to reallocate resources quickly and smoothly in response to changes' (Buckley and Casson, 1998: 23). Strategic flexibility is a firm-level construct that explores the portfolio of investments a firm has created over time (Sanchez, 1993; Kogut and Kulatilaka, 1994). These past investments can lead to greater flexibility in future investments, reducing the potential impact of downside risk (Tong and Reuer, 2007) because investments/output can be shifted within a firm's network as a means of avoiding any adverse effects (Sanchez, 1993).

The biggest concern with the empirical research looking at strategic flexibility (Table 2, Panel D) is that it implies that shifting of production or technology is costless and that firms can control such actions. But researchers have argued that the ability to gain from switching options (in MNEs) depends on factors such as the size or structure (governance mode) of the firm's portfolio of past investments or cultural differences, which can increase complexity and coordination costs (Tong and Reuer, 2007). Consequently, future research needs to focus on the boundary conditions for switching options in multinational investments. Moreover, researchers can also explore how firms develop switching options in non-MNE investments, for example, technology investments. It might be that firms with greater product portfolios have greater technical strategic flexibility, since technologies that fail in one area could be applied to another product area. Yet, firm governance might impact the ability to transfer technology between units, restricting any flexibility available to the firm.

Timing and options

Based on the uncertainties it faces as well as the impact of the four moderating factors, firms must decide on the investment timing and the related real option choice: deferral or growth (abandonment) option. Deferral options provide a firm with the ability to postpone investments until a later date while maintaining the right but not the obligation to make such future investments (Copeland and Keenan, 1998). Growth options enable a firm to expand an investment in the future (Kogut, 1991). Deferral and growth options are thus similar to 'call options' in finance (Li and Chi, 2013). Abandonment options, on the other hand, are like financial 'put options', which provide the firm an option to sell or withdraw from a project (Copeland and Keenan, 1998; Li and Chi, 2013). Theoretical real option papers suggest that a firm should invest when the growth option value surpasses that of the deferral option (Bowman and Hurry, 1993; Sanchez, 1993) or, put differently, they should delay entry as long as 'the value of waiting exceeds the benefits from moving quickly' (Miller and Folta, 2002: 655; Newton *et al.,* 2004).

Studies on option timing focus on a variety of contexts, including technology or R&D investments (e.g., McGrath and Nerkar, 2004; Cuervo-Cazurra and Un, 2010) as well as timing of investments in new markets and new products (e.g., Folta and O'Brien, 2004; Hawk *et al.,* 2013) and highlight factors that prompt (e.g., technical experience, existence of numerous competitors) or deter investments (e.g., market uncertainty).

A major concern with research on timing arises because real option decisions are made by managers with data about future, uncertain issues (Miller and Shapira, 2004). Because the main antecedents and moderators to real option decisions cannot be accurately measured, there is room for manipulation, either intentionally or because of managerial biases (Krychowski and Quelin, 2010; Driouchi and Bennett, 2012). Although researchers have noted that managerial biases might play a role in real option decisions, we found no studies that empirically examined how managerial biases and manipulation influence real option investment timing decisions, which constitutes an important future research direction. Further, research using experiments could help identify mechanisms to overcome these biases or techniques to reduce the chances of information manipulation in real option investment timing decisions.

Structure/governance mode

For firms looking to acquire a growth/abandonment option, research focuses on the organizational structure or governance mode used, predominantly with regard to technology (e.g., Steensma and Corley, 2001; Santoro and McGill, 2005; Ziedonis, 2007) and market entry investments (e.g., Chari and Chang, 2009; Xu *et al.,* 2010; Tong and Li, 2011). This literature suggests that certain organizational structures or governance modes

provide companies with more flexibility (real options) than others, e.g. equity collaborations (Folta, 1998) or greenfield investments more than acquisitions (Brouthers and Dikova, 2010) or joint ventures (JVs) more than wholly-owned subsidaries (Brouthers *et al.,* 2008).

Although these studies provide valuable insights about the governance modes firms use to capture a real growth/abandonment option, there are a number of concerns. First, while joint ventures and other structures theoretically provide an option, most of these organizational structures do not specifically provide for future investments. Reuer and Tong (2005) found that only about 1% of the international JV agreements they reviewed contained an explicit buyout clause. Because of this, growth/abandonment option governance modes may not provide expected returns for firms in the future, since the buyout or expansion costs are negotiated in the future when uncertainty is low and all parties have more knowledge on which to base the price. Future research needs to explore how these specific buyout clauses impact the potential value of holding a growth/abandonment option.

A second concern is that this research tends to ignore the link between acquiring a new option and its impact on the existing investment (option) portfolio (Trigeorgis, 1993). A firm's investment portfolio is related to the switching options available to the firm. Because of this, a new investment may provide the firm not only with a potential growth/abandonment option, but it could also influence the value of other options. Future research can develop and test theory in this area to determine how current option structure decisions influence the value of the portfolio of investments the firm currently holds, for example how a growth option market entry investment in a particular world region alters the value of existing real option investments in the same region.

Circumstances of option exercise

The next component of the real option decision process explores the circumstances under which real options are exercised. Normally, the exercise of a real option takes one of two forms: the firm buys more equity in the investment or the firm divests. ROT suggests that as long as exogenous uncertainties are high, firms will not exercise the option, since holding the option allows the firm to take advantage of future opportunities should they develop while minimizing downside risk if uncertainty resolves unfavorably (Vassolo *et al.,* 2004; Li and Chi, 2013). But as exogenous uncertainties decrease, firms can make decisions about the future direction they want to take.

Research looking at option exercise and the factors that trigger/postpone it have investigated technology investments (e.g., Folta and Miller, 2002; Vassolo *et al.,* 2004), market entry investments (e.g., Kogut, 1991; Belderbos and Zou, 2009; Damaraju *et al.,* 2015) and divestments/market exit (Li and Chi, 2013; Elfenbein and Knott, 2015). While these studies help us gain some understanding about the circumstances in which firms exercise real options, more work is needed. Most importantly, we know little about option exercise timing, although this is a prominent topic in the theoretical literature which offers mathematical modeling solutions (e.g., Hurry, 1993; Kulatilaka and Perotti, 1998; Smit and Trigeorgis, 2017). In addition, we do not know how the time between acquiring an option and exercising the option influences the decision. Exogenous uncertainties take time to resolve. During this time, managers switch attention to other activities of the firm or firms might change managers. Future research needs to look at option exercise timing and at this time gap (e.g., by means of longitudinal case studies) and explore how it impacts the value generated from holding/exercising options.

Furthermore, some of the research we reviewed indicates that the existence of competitors can influence the way growth or abandonment real options are exercised (e.g., Kogut, 1991; Jiang *et al.,* 2009). However, it is unclear whether the presence of more competitors in a technology or market area leads to earlier or later exercise of options. One argument is that competition leads to earlier option exercise if the firm can get first mover advantages (Jiang *et al.,* 2009). But an alternative argument suggests that competitor actions might lead to later exercise of options, while firms wait to see the outcome of a rival's actions. Future research can help resolve this issue by examining these alternatives. More specifically, future research might investigate which types of competitive actions or which contextual factors (e.g., industry, firm size, etc.), respectively, lead to earlier/later exercise of the option.

Real option value/performance

The reason management scholars are excited about real option logic is the hope that it will result in improved performance. Researchers have looked at this issue of performance from three perspectives (Table 3). One part of this research looks at the value of the options a firm might acquire or hold. These studies suggest that possessing a portfolio of real options or making real option investment decisions improves overall firm value (e.g., Lee and Makhija, 2009a, 2009b; Yang *et al.,* 2014). The second perspective focuses on the financial consequences (firm performance) of making a real option decision (e.g., Kumar, 2005; Hawk *et al.,* 2013; Klingebiel and Adner, 2015), while the third part discusses individual performance (Raffiee and Feng, 2014).

Although all these studies provide evidence about the effectiveness of using real option reasoning in management, more work is needed. One issue with many

Table 3 Performance

Type	*Example measures*	*Sample studies*
Option value	Students' valuation decisions	Miller and Shapira (2004)
	Tobin's q	Lee and Makhija (2009a, 2009b)
		Hasan *et al.* (2011)
		Yang *et al.* (2014)
	Market value of a firm's R&D capital	Oriani and Sobrero (2008)
	Stern Stuard data on Economic Value Added	Tong *et al.* (2008a, 2008b)
		Alessandri *et al.* (2012)
	Book leverage, market leverage	Liu and Wong (2011)
Firm performance	Satisfaction with subsidiary performance	Brouthers *et al.* (2008)
	Entry performance (cumulative abnormal stock market return)	Hawk *et al.* (2013)
	Abnormal returns	Kumar (2005)
	Firms' turnover generated by new product sales	Klingebiel and Adner (2015)
Individual performance	Full–time self–employment survival	Raffiee and Feng (2014)

of the studies looking at real option value is a confounding of real option value with overall firm value. This occurs because the measures used to calculate value – Tobin's q or abnormal returns – cannot distinguish between the value impact of the options and the firm (Reuer and Tong, 2007). Researchers need to work towards developing better tools for distinguishing between real option value and firm value (e.g., by focusing on developing perceptual indicators of option performance, see Table 3). Another issue with this research is that studies rely on secondary data. It is very difficult to identify and capture all the options a firm might possess and adequately understand their internal benefits simply by looking at published data. Because firms differ in their ability to capture the value of options, possessing access to options may provide greater/lesser value to one firm than to another. Gaining greater insights about firm differences and the relation between firm capabilities, resources, and strategy on the one hand and the real options a firm might possess on the other can help advance our understanding of the potential value of real options. This will necessarily require primary data collection.

Furthermore, most scholars tend not to look at the performance impact of making real option decisions. Therefore, more work is needed to determine under what conditions firms actually generate performance benefits from taking a real option perspective (Klingebiel and Adner, 2015). As we suggested when discussing the different parts of the real option process above, future research needs to explore how each component of the real option process impacts the performance benefits a firm generates from taking a real option perspective.

Discussion, limitations and conclusion

Discussion

Ever since Kogut (1991) first introduced the idea of real options in the management literature, researchers have explored the benefits of using real option logic when making decisions under uncertainty. Our review of the empirical research published in leading management journals during this 25-year period differs from past reviews in the area and contributes to this work in several important ways. First, unlike past reviews that focus on specific real option areas like international expansion (Li, 2007) or R&D decisions (Newton *et al.,* 2004), we systematically explore all the areas encompassed in management research during this period. Despite the variety of topic areas to which real option theory has been applied, important issues appear to have been ignored, which we discuss in the next sections (Sparsely or hitherto not covered areas and New emergent areas).

Second, this study makes a contribution by refining our understanding of the factors and outcomes in the real option process (Figure 1). Past reviews/critiques provide basic and conflicting models of the real option process (e.g., Reuer and Tong, 2007; Driouchi and Bennett, 2012; Smit and Trigeorgis, 2017). In our review, we tried to untangle these conflicts and identified a number of important antecedents, moderators, and timing issues in real option models of managerial decision-making. The model we present is more inclusive and detailed and helps show the relationship between the different phases of the real option decision process. This more comprehensive model helps highlight additional shortcomings in current real option research and can be used to help guide new research.

Finally, we make a contribution by identifying the major issues raised in past studies and note the empirical studies that have begun addressing these points and where important research questions remain unaddressed. Past reviews/critiques have made a number of recommendations to help move our knowledge forward. Some of these issues have been addressed in the empirical research we reviewed, while other recommendations remain unexplored. Below, based on our understanding of the literature and on recommendations articulated in

existing reviews, we identify areas where research is still needed.

Sparsely or hitherto not covered areas. While international strategy issues have been the main focus of much of the real option work we reviewed, these studies tend to focus on the structure choice. However, one of the first steps a firm takes when internationalizing is to select a country to enter. Country selection is fraught with uncertainties due in large part to differing institutional settings (Xu and Shenkar, 2002). Existing real options research has not covered this important decision. It could be that making small entries into multiple countries is better than entering one or two countries with large scale operations. Scholars might find that taking a real option approach to country selection improves international strategy decisions.

Real option researchers have also explored decisions involving expanding existing technologies (e.g., Kim and Kogut, 1996; Ziedonis, 2007), or for the development of new technologies (e.g., Folta, 1998; McGrath and Nerkar, 2004; Liu and Wong, 2011). New research based on real option logic might also make a contribution by looking at other areas of technology strategy, such as technology divestment.

Those real option papers looking at operation management issues include studies investigating the expansion/divestment of existing operations (e.g., Kogut, 1991; Folta and Miller, 2002; Xu *et al.,* 2010), as well as the entry into new industries (Campa, 1994; Folta and O'Brien, 2004; Hawk *et al.,* 2013). Future research might employ real option logic to look at other operation decisions such as those involving product diversity. It might be that increasing (decreasing) product diversity can impact the value of existing real options the firm possesses.

A few researchers use real option logic to explore the area of entrepreneurship. These studies examine (corporate) venture capital investment/withdrawal (e.g., Hurry *et al.,* 1992; Tong and Li, 2011; Moschieri and Mair, 2017), hybrid entrepreneurship (Folta *et al.,* 2010; Raffiee and Feng, 2014), and IPOs (Reuer and Tong, 2010). While these studies have begun improving our understanding of entrepreneurial decision-making and the consequences of this choice from a real option perspective, future research might be able to make significant advances in understanding other entrepreneurial issues like entrepreneurial re-entry, serial/portfolio entrepreneurship or the relationship between entrepreneurial orientation and investment strategy (real option vs. non-option strategy). Investigating this area in more detail is important since research has shown that entrepreneurs and managers differ with regard to personality traits, e.g. in their risk propensity (Stewart Jr and Roth, 2001), which might impact the applicability of ROT.

Furthermore, entrepreneurship theory might help us gain a better understanding of why some firms recognize real options while others do not. Bowman and Hurry (1993) suggested that options remain shadow options unless they are detected. Research exploring how, why and when firms recognize and can exploit real options (e.g., by using a case-study methodology) provides opportunities for future research.

One concern expressed in numerous real option studies (e.g., Adner and Levinthal, 2004 ; Reuer and Tong, 2007) has to do with identifying clear differences between real option firms and more traditional firms (those relying on discounted cash flow models or path dependency). Some work has been attempted (Hurry *et al.,* 1992; Brouthers *et al.,* 2008), yet except for one paper (Klingebiel and Adner, 2015), none of these studies actually looks at the decision process (real option decisions versus other decision-models) firms use, instead relying on differences in outcomes to suggest different decision model use. More work is needed that more closely inspects firms' decision-making processes, including who makes decisions, who is entitled to suggest courses of action and how this process is structured over time. Moreover, the type of real option application (real option reasoning or real option valuation) needs to be elicited in order to find out which of these methods leads to enhanced performance.

Another concern expressed in earlier reviews/critiques has to do with the role of managerial cognition, firm capabilities, and how attitudes and biases might impact real option decisions (Smit and Trigeorgis, 2017). With only one exception (Miller and Shapira, 2004), none of the empirical studies we reviewed addresses these important issues. Future research can make an important contribution to this question by using experimental designs to study this topic.

Several reviews/critiques recommend improvement in the proxies used to measure real option constructs as well as the need to consider additional factors that impact the value of taking, holding and exercising options (e.g., Newton *et al.,* 2004; Reuer and Tong, 2007). We noted similar concerns in our review. Despite increased interest in real option decision-making, improvement is still needed in the way many real option constructs are measured and to account for how additional factors impact real option value.

Other issues raised in prior reviews/critiques include the need to combine real option logic with other theories to help build our understanding of the factors influencing managerial decisions (Li, 2007; Reuer and Tong, 2007). More research also has been recommended in areas such as abandonment options (Adner and Levinthal, 2004; Reuer and Tong, 2007), investment timing, corporate

venture capital, IPOs or contracting (Reuer and Tong, 2007). While some progress has been made in a number of these areas (e.g., Brouthers *et al.,* 2008; Fisch, 2008; Li and Chi, 2013), more empirical research is needed in order to solidify the findings of these few representative studies.

Finally, several past reviews have suggested that more work needs to focus on the use of real options in practice (Reuer and Tong, 2007; Driouchi and Bennett, 2012). Gathering data on decision-makers' attitudes towards and actual use of real options analysis can help researchers understand the strengths and weaknesses of this method in practice. With such knowledge, future studies can focus on improving the usefulness of real option logic and make it more accessible to firms and managers for making decisions involving uncertainty. Despite these potential benefits, none of the empirical research included in our study actually looks at real options in practice.

New emergent areas. Our review also helped identify a topic area where real option logic has not been applied. None of the studies in our review looked at the impact of the internet or how technological developments might change the application of ROT in the future, but the information age has created significant levels of uncertainty for firms (Brouthers *et al.,* 2016). The disruption caused by new technologies such as the internet, artificial intelligence, mobile communications, or big data analysis is likely to have an impact on how business is conducted and this, in turn, might have an effect on the decisions to which real option logic can be applied and how it can be applied.

Developments in the area of artificial intelligence could help managers calculate a real option's value with greater ease. Moreover, as noted earlier in our review, researchers have articulated a lack of good proxies for key real option parameters, however, with masses of data collected via the internet and the development of new techniques to make use of this data, firms will be equipped with more input data for applying real option logic, which might increase its use in the future.

Limitations

Our review suffers from a number of limitations that offer opportunities for future researchers. First, we limited our review to empirical research. We did not review the theoretical or mathematical modelling papers on real options in management. Future research could look at these to see where additional work is needed. Second, we restricted our review to papers published in the top management journals, but other management journals also publish real option papers, which might have addressed issues raised in this review. Future research might look at a different mix of journals (maybe by area such as entrepreneurship or human resource management) and review the literature in these specific areas.

Finally, our study is limited because we did not look at the literature examining the use of real option logic in practice. Driouchi and Bennett (2012) reviewed some of this work and note that only a small percentage of large firms has heard of or utilizes this technique. Future research could make a contribution by providing a more systematic review of the literature addressing this issue and identifying how and why real option logic is (not) used in practice.

Conclusion

Despite some limitations, our review makes an important contribution to knowledge. By utilizing a systematic method to review the empirical research in management, we help identify topic areas ignored in past reviews/critiques and illuminate issues for future research. This method also helped us to identify issues related to measures and models which cross topic areas. We also contribute by developing a more comprehensive model of the real option process and show areas needing additional research. Finally, our review helps identify other opportunities for future research and highlights the need for researchers to solve critical questions that remain unresolved.

References

Adner, R. and D. A. Levinthal, 2004, "What is not a real option: Considering boundaries for the application of real options to business strategy". *Academy of Management Review*, **29**: 74–85.

Alessandri, T. M., T. W. Tong and J. J. Reuer, 2012, "Firm heterogeneity in growth option value: The role of managerial incentives". *Strategic Management Journal*, **33**: 1557–1566.

Armstrong, C. E. and K. Shimizu, 2007, "A review of approaches to empirical research on the resource-based view of the firm". *Journal of Management*, **33**: 959–986.

Barreto, I., 2010, "Dynamic capabilities: A review of past research and an agenda for the future". *Journal of Management*, **36**: 256–280.

Belderbos, R. and J. Zou, 2007, "On the growth of foreign affiliates: Multinational plant networks, joint ventures, and flexibility". *Journal of International Business Studies*, **38**: 1095–1112.

Belderbos, R. and J. Zou, 2009, "Real options and foreign affiliate divestments: A portfolio perspective". *Journal of International Business Studies*, **40**: 600–620.

Belderbos, R., T. W. Tong and S. Wu, 2014, "Multinationality and downside risk: The roles of option portfolio and organization". *Strategic Management Journal*, **35**: 88–106.

Bowman, E. H. and D. Hurry, 1993, "Strategy through the option lens: An integrated view of resource investments and the incremental-choice process". *Academy of Management Review*, **18**: 760–782.

Briner, R. B. and D. Denyer, 2012. "Systematic review and evidence synthesis as a practice and scholarship tool". In Rousseau D. M. (ed.), *Handbook of evidence-based management: Companies, classrooms and research*. New York: Oxford University Press, pp. 112–129.

Brouthers, K. D. and D. Dikova, 2010, "Acquisitions and real options: The greenfield alternative". *Journal of Management Studies*, **47**: 1048–1071.

Brouthers, K. D., L. E. Brouthers and S. Werner, 2008, "Real options, international entry mode choice and performance". *Journal of Management Studies*, **45**: 936–960.

Brouthers, K. D., K. D. Geisser and F. Rothlauf, 2016, "Explaining the internationalization of ibusiness firms". *Journal of International Business Studies*, **47**: 513–534.

Buckley, P. J. and M. C. Casson, 1998, "Models of the multinational enterprise". *Journal of International Business Studies*, **29**: 21–44.

Burger-Helmchen, T., 2007, "Justifying the origins of real options and their difficult evaluation in strategic management". *Schmalenbach Business Review*, **59**: 387–405.

Campa, J. M., 1994, "Multinational investment under uncertainty in the chemical processing industries". *Journal of International Business Studies*, **25**: 557–578.

Chari, M. D. and K. Chang, 2009, "Determinants of the share of equity sought in cross-border acquisitions". *Journal of International Business Studies*, **40**: 1277–1297.

Chi, T., 2000, "Option to acquire and divest a joint venture". *Strategic Management Journal*, **21**: 665–687.

Chi, T. and D. J. McGuire, 1996, "Collaborative ventures and value of learning: Integrating the transaction cost and strategic option perspectives on the choice of market entry modes". *Journal of International Business Studies*, **27**: 285–307.

Chung, C. C., S. H. Lee, P. W. Beamish and T. Isobe, 2010, "Subsidiary expansion/contraction during times of economic crisis". *Journal of International Business Studies*, **41**: 500–516.

Clark, B. H. and D. B. Montgomery, 1996, "Perceiving competitive reactions: The value of accuracy (and paranoia)". *Marketing Letters*, **7**: 115–129.

Colombo, M. G., 2003, "Alliance form: A test of the contractual and competence perspectives". *Strategic Management Journal*, **24**: 1209–1229.

Copeland, T. E. and P. T. Keenan, 1998, "How much is flexibility worth?" *The McKinsey Quarterly*, **2**: 38–49.

Crossan, M. M. and M. Apaydin, 2010, "A multi-dimensional framework of organizational innovation: A systematic review of the literature". *Journal of Management Studies*, **47**: 1154–1191.

Cuervo-Cazurra, A. and C. A. Un, 2010, "Why some firms never invest in formal R&D". *Strategic Management Journal*, **31**: 759–779.

Cuypers, I. R. and X. Martin, 2010, "What makes and what does not make a real option? A study of equity shares in international joint ventures". *Journal of International Business Studies*, **41**: 47–69.

Damaraju, N. L., J. B. Barney and A. K. Makhija, 2015, "Real options in divestment alternatives". *Strategic Management Journal*, **36**: 728–744.

Denyer, D. and D. Tranfield, 2009. "Producing a systematic review". In Buchanan D. A. and A. Bryman (eds.), *The Sage handbook of organizational research methods*. Thousand Oaks, CA: Sage Publications, pp. 671–689.

Dixit, A. K. and R. S. Pindyck, 1994. *Investment under uncertainty*. Princeton, NJ: Princeton University Press.

Driouchi, T. and D. J. Bennett, 2012, "Real options in management and organizational strategy: A review of decision-making and performance implications". *International Journal of Management Reviews*, **14**: 39–62.

Drummond, H., 2014, "Escalation of commitment: When to stay the course". *Academy of Management Perspectives*, **28**: 430–446.

Elfenbein, D. W. and A. M. Knott, 2015, "Time to exit: Rational, behavioral, and organizational delays". *Strategic Management Journal*, **36**: 957–975.

Fisch, J. H., 2008, "Investment in new foreign subsidiaries under receding perceptions of uncertainty". *Journal of International Business Studies*, **39**: 370–386.

Fisch, J. H. and M. Zschoche, 2012, "The role of operational flexibility in the expansion of international production networks". *Strategic Management Journal*, **33**: 1540–1556.

Folta, T. B., 1998, "Governance and uncertainty: The trade–off between administrative control and commitment". *Strategic Management Journal*, **19**: 1007–1028.

Folta, T. B. and K. D. Miller, 2002, "Real options in equity partnerships". *Strategic Management Journal*, **23**: 77–88.

Folta, T. B. and J. B. O'Brien, 2004, "Entry in the presence of dueling options". *Strategic Management Journal*, **25**: 121–138.

Folta, T. B., F. Delmar and K. Wennberg, 2010, "Hybrid entrepreneurship". *Management Science*, **56**: 253–269.

Ghahremani, M., A. Aghaie and M. Abedzadeh, 2012, "Capital budgeting technique selection through four decades: With a great focus on real option". *International Journal of Business and Management*, **7**: 98–119.

Gough, D., 2007, "Weight of evidence: A framework for the appraisal of the quality and relevance of evidence". *Research Papers in Education*, **22**: 213–228.

Hasan, I., N. Kobeissi and H. Wang, 2011, "Global equity offerings, corporate valuation, and subsequent international diversification". *Strategic Management Journal*, **32**: 787–796.

Hawk, A., G. Pacheco-de-Almeida and B. Yeung, 2013, "Fast-mover advantages: Speed capabilities and entry into the emerging submarket of Atlantic Basin LNG". *Strategic Management Journal*, **34**: 1531–1550.

Huchzermeier, A. and C. H. Loch, 2001, "Project management under risk: Using the real options approach to evaluate flexibility in R&D". *Management Science*, **47**: 85–101.

Hurry, D., 1993, "Restructuring in the global economy: The consequences of strategic linkages between Japanese and US firms". *Strategic Management Journal*, **14**: 69–82.

Hurry, D., A. T. Miller and E. H. Bowman, 1992, "Calls on high-technology: Japanese exploration of venture capital investments in the United States". *Strategic Management Journal*, **13**: 85–101.

Janney, J. J. and G. G. Dess, 2004, "Can real-options analysis improve decision-making? Promises and pitfalls". *Academy of Management Executive*, **18**: 60–75.

Jiang, M. S., P. S. Aulakh and Y. Pan, 2009, "Licensing duration in foreign markets: A real options perspective". *Journal of International Business Studies*, **40**: 559–577.

Kim, D.-J. and B. Kogut, 1996, "Technological platforms and diversification". *Organization Science*, **7**: 283–301.

Klingebiel, R. and R. Adner, 2015, "Real options logic revisited: The performance effects of the alternative resource allocation regimes". *Academy of Management Journal*, **58**: 221–241.

Kogut, B., 1991, "Joint ventures and the option to expand and acquire". *Management Science*, **37**: 19–33.

Kogut, B. and N. Kulatilaka, 1994, "Operating flexibility, global manufacturing, and the option value of a multinational network". *Management Science*, **40**: 123–139.

Krychowski, C. and B. V. Quelin, 2010, "Real options and strategic investment decisions: Can they be of use to scholars?" *Academy of Management Perspectives*, **24**: 65–78.

Kulatilaka, N. and E. C. Perotti, 1998, "Strategic growth options". *Management Science*, **44**: 1021–1031.

Kumar, S., 2005, "The value from acquiring and divesting a joint venture: A real options approach". *Strategic Management Journal*, **26**: 321–331.

Lee, S.-H. and M. Makhija, 2009a, "Flexibility in internationalization: Is it valuable during an economic crisis?" *Strategic Management Journal*, **30**: 537–555.

Lee, S.-H. and M. Makhija, 2009b, "The effect of domestic uncertainty on the real options value of international investments". *Journal of International Business Studies*, **40**: 405–420.

Leiblein, M. J. and D. J. Miller, 2003, "An empirical examination of transaction- and firm-level influences on the vertical boundaries of the firm". *Strategic Management Journal*, **24**: 839–859.

Li, J., 2007, "Real options theory and international strategy: A critical review". *Advances in Strategic Management*, **24**: 67–101.

Li, Y. and T. Chi, 2013, "Venture capitalists' decision to withdraw: The role of portfolio configuration from a real options lens". *Strategic Management Journal*, **34**: 1351–1366.

Li, J. and Y. Li, 2010, "Flexibility versus commitment: MNEs' ownership strategy in China". *Journal of International Business Studies*, **41**: 1550–1571.

Liu, Q. and K. P. Wong, 2011, "Intellectual capital and financing decisions: Evidence from the US patent data". *Management Science*, **57**: 1861–1878.

McGrath, R. G., 1997, "A real options logic for initiating technology positioning investment". *Academy of Management Review*, **22**: 974–996.

McGrath, R. G., 1999, "Falling forward: Real options reasoning and entrepreneurial failure". *Academy of Management Review*, **24**: 13–30.

McGrath, R. G. and A. Nerkar, 2004, "Real options reasoning and a new look at the R&D investment strategies of pharmaceutical firms". *Strategic Management Journal*, **25**: 1–21.

Miller, K. D. and T. B. Folta, 2002, "Option value and entry timing". *Strategic Management Journal*, **23**: 655–665.

Miller, K. D. and Z. Shapira, 2004, "An empirical test of heuristics and biases affecting real option valuation". *Strategic Management Journal*, **25**: 269–284.

Moschieri, C. and J. Mair, 2017, "Corporate entrepreneurship: Partial divestitures as a real option". *European Management Review*, **14**: 67–82.

Mun, J., 2002. *Real options analysis: Tools and techniques for valuing strategic investments and decisions*. Hoboken, NJ: John Wiley and Sons.

Myers, S. C., 1977, "Determinants of corporate borrowing". *Journal of Financial Economics*, **5**: 147–175.

Newton, D. P., D. A. Paxson and M. Widdicks, 2004, "Real R&D options". *International Journal of Management Reviews*, **5**: 113–130.

Oriani, R. and M. Sobrero, 2008, "Uncertainty and the market valuation of R&D within a real options logic". *Strategic Management Journal*, **29**: 343–361.

Pittaway, L., M. Robertson, K. Munir, D. Denyer and A. Neely, 2004, "Networking and innovation: a systematic review of the evidence". *International Journal of Management Reviews*, **5**: 137–168.

Raffiee, J. and J. Feng, 2014, "Should I quit my day job? A hybrid path to entrepreneurship". *Academy of Management Journal*, **57**: 936–963.

Ragozzino, R., J. Reuer and L. Trigeorgis, 2016, "Real options in strategy and finance: Current gaps and future linkages". *The Academy of Management Perspectives*, **30**: 428–440.

Reuer, J. J. and M. J. Leiblein, 2000, "Downside risk implications of multinationality and international joint ventures". *Academy of Management Journal*, **43**: 203–214.

Reuer, J. J. and T. W. Tong, 2005, "Real options in international joint ventures". *Journal of Management*, **31**: 403–423.

Reuer, J. J. and T. W. Tong, 2007, "How do real options matter? Empirical research on strategic investments and firm performance". *Advances in Strategic Management*, **24**: 145–173.

Reuer, J. J. and T. W. Tong, 2010, "Discovering valuable growth opportunities: An analysis of equity alliances with IPO firms". *Organization Science*, **21**: 202–215.

Rivoli, P. and E. Salorio, 1996, "Foreign direct investment and investment under uncertainty". *Journal of International Business Studies*, **27**: 335–357.

Sanchez, R., 1993, "Strategic flexibility, firm organization, and managerial work in dynamic markets: A strategic-options perspective". In P. Shrivastava and R. Lamb (eds.). *Advances in Strategic Management*, **9**: 251–291.

Santoro, M. D. and J. P. McGill, 2005, "The effect of uncertainty and asset co-specialization on governance in biotechnology alliances". *Strategic Management Journal*, **26**: 1261–1269.

Schmeisser, B., 2013, "A systematic review of literature on offshoring of value chain activities". *Journal of International Management*, **19**: 390–406.

Schoemaker, P. J., 1995, "Scenario planning: a tool for strategic thinking". *Sloan Management Review*, **36**: 25–40.

Sitkin, S. B. and L. R. Weingart, 1995, "Determinants of risky decision-making behavior: A test of the mediating role of risk perceptions and propensity". *Academy of Management Journal*, **38**: 1573–1592.

Smit, H. T. J. and L. Trigeorgis, 2017, "Strategic NPV: Real options and strategic games under different information structures". *Strategic Management Journal*, **38**: 2555–2578.

Steensma, H. K. and K. G. Corley, 2001, "Organizational context as a moderator of theories on firm boundaries for technology sourcing". *Academy of Management Journal*, **44**: 271–291.

Stewart, W. H. Jr. and P. L. Roth, 2001, "Risk propensity differences between entrepreneurs and managers: A meta-analytic review". *Journal of Applied Psychology*, **86**: 145–153.

Tong, T. W. and Y. Li, 2011, "Real options and investment mode: Evidence from corporate venture capital and acquisition". *Organization Science*, **22**: 659–674.

Tong, T. W. and S. Li, 2013, "The assignment of call option rights between partners in international joint ventures". *Strategic Management Journal*, **34**: 1232–1243.

Tong, T. W. and J. J. Reuer, 2007, "Real options in multinational corporations: Organizational challenges and risk implications". *Journal of International Business Studies*, **38**: 215–230.

Tong, T. W., J. J. Reuer and M. W. Peng, 2008a, "International joint ventures and the value of growth options". *Academy of Management Journal*, **51**: 1014–1029.

Tong, T. W., T. M. Alessandri, J. J. Reuer and A. Chintakananda, 2008b, "How much does country matter? An analysis of firms' growth options". *Journal of International Business Studies*, **39**: 387–405.

Tranfield, D., D. Denyer and P. Smart, 2003, "Towards a methodology for developing evidence-informed management knowledge by means of systematic review". *British Journal of Management*, **14**: 207–222.

Trigeorgis, L., 1993, "The nature of option interactions and the valuation of investments with multiple real options". *Journal of Financial and Quantitative Analysis*, **28**: 1–20.

Trigeorgis, L., 1996. *Real options: Managerial flexibility and strategy in resource allocation*. Cambridge, MA: MIT Press.

Vassolo, R. S., J. Anand and T. B. Folta, 2004, "Non-additivity in portfolios of exploration activities: A real options-based analysis of equity alliances in biotechnology". *Strategic Management Journal*, **25**: 1045–1061.

Villalonga, B. and A. M. McGahan, 2005, "The choice among acquisitions, alliances, and divestitures". *Strategic Management Journal*, **26**: 1183–1208.

Warner, A. G., J. F. Fairbank and H. K. Steensma, 2006, "Managing uncertainty in a formal standards-based industry: A real options perspective on acquisition timing". *Journal of Management*, **32**: 279–298.

Williamson, O. E., 1985. *The economic institutions of capitalism*. New York: Free Press.

Xu, D. and O. Shenkar, 2002, "Institutional distance and the multinational enterprise". *Academy of Management Review*, **27**: 608–618.

Xu, D., C. Zhou and P. H. Phan, 2010, "A real options perspective on sequential acquisitions in China". *Journal of International Business Studies*, **41**: 166–174.

Yang, Y., V. K. Narayanan and D. M. De Carolis, 2014, "The relationship between portfolio diversification and firm value: The evidence from corporate venture capital activity". *Strategic Management Journal*, **35**: 1993–2011.

Ziedonis, A. A., 2007, "Real options in technology licensing". *Management Science*, **53**: 1618–1633.